Coastal and Ocean Data Assimilation

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LONGTERM GOALS

The long range scientific goal of this proposal is to produce optimal estimates of the state space of the ocean, its marginal seas, and coastal zones in order to document, understand, and predict average conditions and variability. This is being accomplished through the use of data assimilation methods for ocean circulation models.

OBJECTIVES

Our primary objective is to develop new, multiscale data assimilation algorithms for both Eulerian and Lagrangian prediction in coastal, ocean, and in transistion regions that optimizes the information from measurements with different eror and sampling characteristics. In particular, how to both combine and assimilate measurements that measure much different scales of motion in domains dominated by heteregenous, broadband dynamics.

APPROACH

Our data analysis and assimilation approachs are based on motioncompensated spacetime interpolation algorithms, state space reduction techniques, AutoRegressive (AR) models, and multiscale field decomposition. In particular, the ReducedOrder Information Filter has been optimized for the latest version of the HYbrid Coordinate Ocean Model (HYCOM) at NRL.

Our two algorithms for the Inverse Lagrangian Prediction problem are based on a particle filter and a montecarlo bruteforce optimization technique.

WORK COMPLETED

1) The Reduced Order Information Filter (ROIF) data assimilation algorithm for the new HYCOM code has been tested. In particular, work with Ashwanth Srinivasan on optimizing the computational intensive “ROIF inversion engine” in the parallel MPI data structure, that is compliant with the official HYCOM code at NRL.

2) A new class of stochastic boundary conditions for parameterizing subgrid scale processes. (Chin *et al.*, 2007).

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3) New techniques for computationallyefficient assimilation of Lagrangian data (Chin *et al.*, 2007; Molcard *et al.*, 2007).

4) Development of two algorithms for the inverse Lagrangian prediction problem.

5) The LAPCOD book was finished and we coauthored four chapters (Chin *et al., 2007*; Mariano and Ryan, 2007; Molcard *et al.*, 2007; Piterbarg *et al.*, 2007) in *Lagrangian Analysis and Predictability of Coastal and Ocean Dynamics*, Griffa, A., D. Kirwan, A.J. Mariano, T. Ozgökmen, and T. Rossby, editors, (2007, In press, Cambridge University Press).

RESULTS

To make ROIF numerics more independent from a model's particular gridding scheme, the "ROIF inversion engine" has been converted by projection onto a set of continuous basis functions. Initial tests with the drifter and altimeter data have been successful. In general the ROIF run is only about 3 times slower that the nonassimilating runs. The code was also successfully parallelized using both MPI and OpenMP paradigms and is now suitable for both shared and distributed memory machines. This new development will allow ROIF implementation to a highresolution, global configuration of HYCOM.

Results from the optimized ROIF for HYCOM are shown in figure 1. These are classic twin experiment simulations starting with bad initial conditions. Figure 1 shows the SSH field at 6 months after initialization for both the nonassimilative reference simulation started from bad initial conditions, the truth simulation, and the ROIFassimilated run that assimilated SSH data sampled from the reference simulation along T/P tracks. Similar good results were seen for the entire two year experiment. The RMS forecast error declined slower for simulations with T/P sampling than for simulations with random sampling of equal number of data points (not shown).

IMPACT/APPLICATIONS

We propose to continue our work with the ReducedOrder Information Filter, multvariate spline representation of oceanic variables, and MonteCarlo based smoothers (Chin *et al.*, 2006) for the assimilation of oceanic and coastal data into numerical circulation models. We have been incorporating these more advanced methods into HYCOM (HYbrid Coordinate Ocean Model), the nextgeneration, operational, ocean model for the US Navy. It should be noted even though the proposed research is with HYCOM, the methods are quite general and can be used with other numerical circulation models

Our algorithms for the Inverse Lagrangian Prediction Problem can be used to derive solutions for the ODDAS, Optimal Design for Drifting Acoustic Sensor, problem.

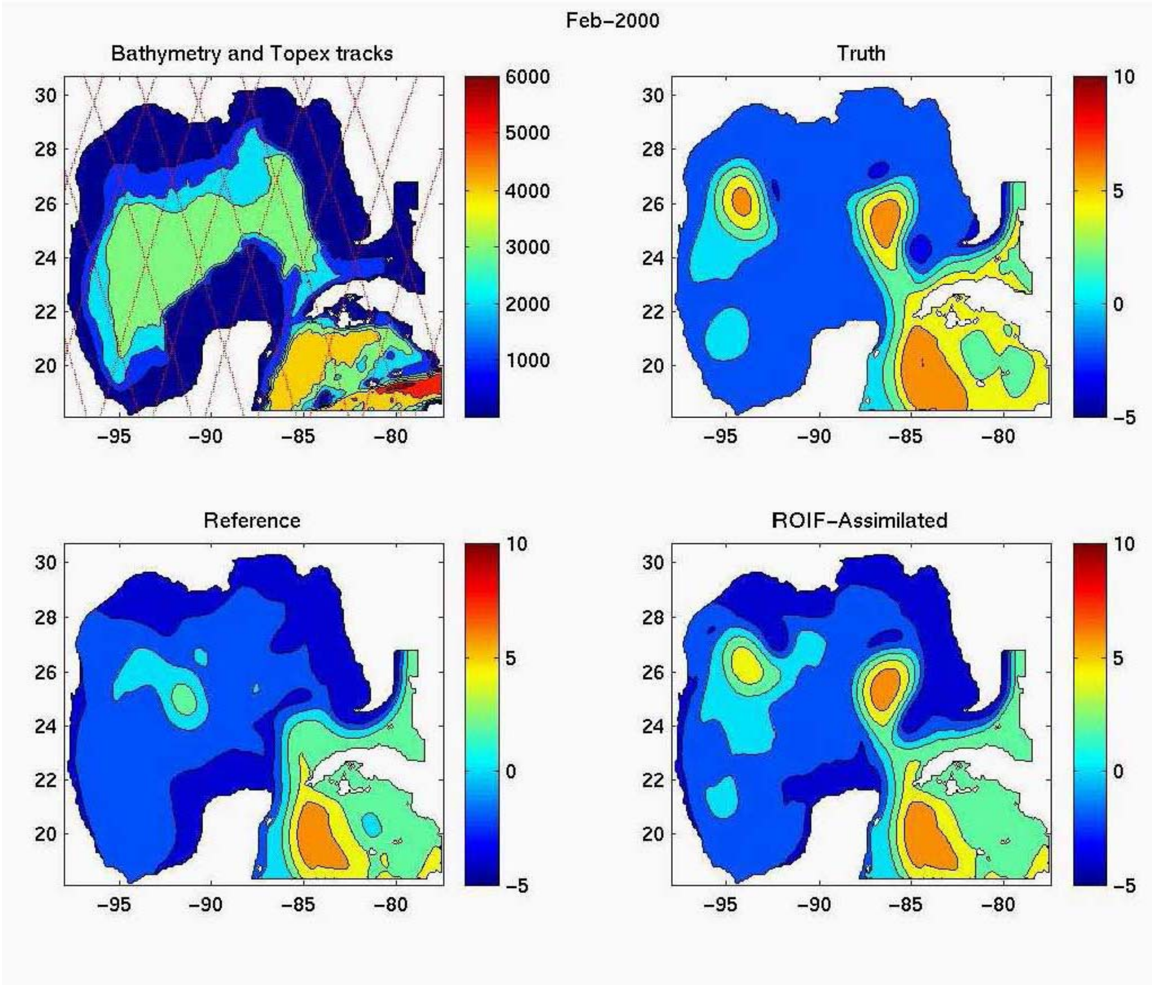

Figure 1. Snapshots of SSH from the truth run and the twin experiments at time six months. The satellite altimeter tracks are shown on the top left. The ROIF assimilation reproduces the primary circulation features see in the truth fields.

TRANSITIONS

These results are being applied to the HYCOM data assimilative modelling consortium's effort to produce a reliable and efficient ocean forecast system for the Navy.

RELATED PROJECTS

This work will be done in collaboration with A. Griffa, T. Ozgokmnen, A. Srinivasan, and the HYCOM Data Assimilative Modelling Consortium. Predictability of particle trajectories in the ocean. T. Ozgökmen (PI) and A. Griffa HYCOM Consortium for DataAssimilative Ocean Modeling. E.P. Chassignet (PI) with coPIs R. Bleck, T. Chin, M. Clancy, G. Halliwell, H. Hurlburt, A.J. Mariano, R. Rhodes, C. Thacker, A. Wallcraft

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